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# Simulation of Two-Phase Flow in an Oil Reservoir using Adaptive High-Order Runge-Kutta based Time-Integration

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Off-shore subsurface oil fields are porous rocks with oil trapped in the pores. Conventional technologies for recovery of this oil in porous rocks leave more than 50% of the oil in the reservoir. Wells with adjustable downhole flow control devices coupled with modern control technology offer the potential to increase the oil recovery significantly. The valve settings could be computed by solution of a large scale constrained optimal control problem implemented in a receding horizon fashion. The major computational effort in this optimal control problem concerns solution of a very large system of differential equations describing the flow of oil and water in the porous rock. We present a two-phase immiscible flow model for the oil reservoir and describe a new explicit singly diagonally implicit Runge-Kutta (ESDIRK) method for computationally efficient solution of this model. The ESDIRK integrator is mass preserving, of high order, and equipped with integration error controll! ers. The ESDIRK methods are computationally competitive to the implicit Euler method normally used for solution of the oil reservoir two phase immiscible flow problem.

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